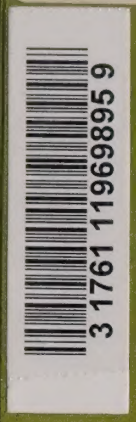

Mineral Development in Ontario North of 50°

Technical Paper #12

Zinc

Dr. H. Strauss
and
Dr. E. T. Willauer

the ROYAL COMMISSION on the NORTHERN ENVIRONMENT

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ZINC

INTRODUCTION

The purpose of this chapter is to investigate the general performance of the Canadian zinc industry with a view to assess the critical areas of interest. They are, besides the general aspects of world zinc consumption, the overall reserves, the exploitation rates of Canada and of the other countries in light of present and future world zinc reserves, the Canadian export structure of zinc in terms of ores and concentrates versus refined zinc and the role which alternative suppliers may be able to play in the future due to their investment activities. It would appear that rising future demand and consumption of zinc as projected by the study will force the main consuming countries increasingly to utilize their own available domestic resources and to increase their exploration activities dramatically. Canada, though not necessarily the Province of Ontario, is in a favourable position in this 'reserve game' thanks to its relatively large zinc resource endowment. However, there is no question that this country could utilize the available resources much better for the general economic welfare of the country were it to export a much larger proportion of refined zinc instead of exporting ores and concentrates which eventually merely reappear on the world zinc market in refined form in competition with our natively refined zinc.

This chapter is organized in the following way: Section I briefly discusses zinc as a metal as to its properties, qualities, occurrences and its usefulness as well as its substitutes. The consumption of zinc in the world and the various applications of the metal in the U.S.A. is explored in Section II. Zinc mine and primary metal production is investigated in Section III, which also tries to shed some light on the changes in the refinery capacities which have taken place in other countries during the period under examination. The importance of Canadian zinc exports is likewise scrutinized in this important section. Section IV is an attempt to assess the world zinc reserves and their distribution and to discuss some of the activities which are taking place in other countries in the zinc industry sector. The future of prices, supply and consumption, based on the econometric analysis, is presented in the last main section with summary and conclusions to follow.

SECTION I: THE METAL

Properties, qualities, occurrence, usefulness and substitutes

Zinc is a bluish-white mineral which is rarely found in native form. It is widely distributed on earth and is very frequently a joint-resource with lead ores.

Its main characteristics are: a low melting point,[1] resistance to atmospheric corrosion, ductility and malleability; it is also soluble in copper alloys. These qualities assure its use in die-castings, galvanizing, and a variety of chemical applications through oxides in batteries, pigments and photo-copying processes. Its strength is generally considered good. Zinc occurs in complex ores mainly with lead, accounting for its very similar distribution to that of lead.

A very interesting point concerns the sources of secondary zinc. Die-castings and respective alloys are important sources of considerable amounts of zinc scrap. However, this does not hold true for zinc which is used up in galvanizing. Such galvanized zinc does not lend itself to easy recovery for secondary purposes: it will rather find its way, through weathering, into the geological-sedimentary cycle and, thus, via streams and rivers to the bottom of the oceans.[2]

Zinc has a number of substitutes and alternate products with which it competes: alumininum and magnesium are the major substitutes for zinc in die-casting while titanium and zirconium

are competitors in pigments and chemicals. In the field of corrosion protection, zinc faces plastic coatings, specialty steels, electro-plated cadmium and paints as substitutes; however, the uses of these substitutes is limited.

SECTION II: CONSUMPTION OF ZINC

The purpose of this section is to show the rise of consumption of zinc in the world between 1950 and 1979, the distribution of that consumption by the various countries and uses to which zinc may be put through the example of the United States of America.

World Consumption of Zinc

The consumption of zinc between 1950 and 1979 increased from 1,985,700 metric tons to 6,178,670 metric tons. This means an increase by 211 percent or by a factor greater than three. This performance is brought out in Table 1 and in Figure 26 of the econometric study of Chapter I. This rise has been continuous through the years even if certain fluctuations are clearly discernible. It can therefore be expected that this development will carry on into the future.

Distribution by Country

The world's largest zinc consumer in the year 1950 was the United States. It absorbed 44.1 percent of the total of 1,985,700 metric tons. By 1979, this relative share had collapsed to a mere 16.3 percent, as its consumption increased but marginally while that of the world as a whole tripled. A similar fate was to meet the relative zinc consumption of the United

Table 1

World Zinc Consumption for the Years 1950 to 1979

in '000 metric tons

Years	'000 metric tons	Years	'000 metric tons
1950	1985.70	1965	4016.63
1951	2055.17	1966	4099.82
1952	1964.18	1967	4081.31
1953	2123.48	1968	4288.43
1954	2370.00	1969	4759.62
1955	2692.40	1970	4639.06
1956	2619.00	1971	4688.50
1957	2660.10	1972	5166.50
1958	2725.20	1973	5536.41
1959	2920.30	1974	5968.10
1960	3077.30	1975	5035.20
1961	3187.36	1976	5723.90
1962	3290.14	1977	5656.66
1963	3466.50	1978	6243.99
1964	3864.22	1979	6178.67

Source: ABMS, Non-ferrous Metal Data, New York, N.Y., respective years and prior publication.

Table 2

World Zinc Consumption and Distribution by Main Consuming Countries for the Years 1950 and 1979 (in percent)

World consumption in '000 metric tons

Country	%	%
U.S.A.	44.1	16.3
Canada	2.5	2.5
Mexico	0.5	1.2
Argentina	0.6	0.6
Brazil	0.5	1.9
Peru	-	0.4
Other America	0.1	0.7
Austria	0.3	0.4
Belgium	3.1	1.8
Denmark	0.3	0.2
France	4.8	4.6
West Germany	5.9	5.9
Italy	1.7	3.7
Netherlands	1.0	0.9
Norway	0.6	0.4
Spain	1.1	1.3
Sweden	1.0	0.6
Switzerland	0.2	0.4
U.K.	12.1	3.9
Other Europe	0.7	0.8

Country	%	%
Yugoslavia	0.5	1.2
Bulgaria	included in other satellite countries	0.8
Germany DR		1.1
Hungary		0.4
Poland		2.9
Rumania		1.0
Czechoslovakia		1.0
other satellite countries	4.6	
U.S.S.R.	6.5	16.0
Cuba	-	0.02
India	1.3	1.7
Japan	2.6	12.4
Other Asia	0.2	5.0
China	-	3.6
North Korea	-	0.4
Africa	0.8	1.8
Australia & New Zealand	2.4	2.0
	100.0	99.8

Kingdom. Its share was reduced from 12.1 percent to 3.9 percent during this period of time as its actual consumption increased by less than 2,000 metric tons.

The third largest consumer in 1950 was the U.S.S.R. It used 6.5 percent of all zinc. By 1979, it had moved into second place behind the United States, holding exactly 16.0 percent of the total. This means that zinc consumption of the Soviet Union rose by more than twice the rate of the total world!

Japan, which had been in seventh position with 2.6 percent, had moved up to third position holding 12.4 percent of the world zinc total. This represents the most spectacular rise of the consumption of zinc of the entire world as its use of zinc increased almost sixteenfold.

Western Germany, France, Italy and Canada are the next most important industrial users of zinc besides the U.K. Of these, only Italy has gained in importance during this period. The other three have expanded at the same rate as the world as a whole.

However, there are a number of countries which are relatively small users of this metal. They may be considered as of secondary significance. Nonetheless, their growth is substantial as may be seen by comparing their distribution for the two years. The countries in point are: Mexico, Brazil, other Asian countries and Africa. Keeping in mind that these

countries or areas are at the outset of industrialization, then, this behaviour is indicative of what can be expected if the industrially underdeveloped countries move ahead or enter the road towards development. This may not necessarily take place within the next twenty-five years - as may be concluded from the famous Leontieff study[3] - but once the process of industrialization gets underway, the demand for zinc will be quickly pressing against the resources which will start to run short sometime in the far future. Just like in the case of lead, it is the rapid industrialization of the less advanced countries which will engender the tremendous growth in the consumption of minerals, especially of zinc and, thus, accelerate its demand. This is quite a different situation from those countries such as the United States and Great Britain, which have arrived at a high level of industrial development. They display an almost stationary consumption of certain minerals, with no signs that the demand will speed up over a long period of time.

Pattern of U.S.A. Consumption

The prime example of industrialization is, no doubt, the United States of America. As a full-fledged economy, a brief analysis of the types of uses will portray the consumption pattern towards which the industrially advancing countries are moving.

This industrial input structure of the American economy has been set out in Table 3. It shows the consumption of slab zinc in the U.S.A. for the years 1973 to 1979 and its distribution by main and sub-categories.

The first surprising observation is that slab zinc consumption between those two years declined in absolute terms by over 25 percent, 1975 being the worst year. Recessionary conditions and a depressed automobile industry are cited to explain the poor performance.[4]

When examining the four main uses of zinc, it is astonishing how stable the pattern of consumption actually is. Of the four uses of a) galvanizing, b) brass and bronze, c) zinc base alloy and d) other uses, brass and bronze as well as other uses exhibit no change at all in relative importance over this period.[5]

A slight increase in importance was noticeable for galvanizing brought about by a mounting importance of 'sheet and strip' materials and of 'structural shapes'. The weight increased from 37.5 (1973) to 43.2 (1978). The relative decrease to match the rise goes with the zinc base alloy category. It fell from 40.6 percent to 33.7 percent of the total brought about mainly by the reduced demand for die-casting alloys. They fell from 39.8 to 32.9 over this time period. The reason for this decline is that the U.S. automakers continued their efforts

Table 3

Consumption of Slab Zinc and its Distribution by Type of Usage

for the Years 1973-1979

Zinc Consumption ('000 metric tons)	1973 1364.4	1974 1168.2	1975 839.5	1976 1028.9	1977 999.5	1978 1050.6	1979 1008.2
Galvanizing							
Sheet and Strip	21.4	22.6	20.1	21.8	23.6	25.6	26.5
Wire and Wire Rope	2.3	2.1	2.7	2.4	2.2	2.2	2.3
Tube and Pipe	4.5	4.7	5.1	4.3	4.3	4.5	4.1
Fitting (for tube & pipe	0.8	0.7	0.7	0.6	0.6	0.6	0.6
Tank and Containers	0.2	0.3	0.2	0.3	0.3	0.3	0.3
Structural Shapes	1.4	2.9	4.4	3.0	2.7	3.2	2.2
Fasteners	0.3	0.4	0.5	0.4	0.4	0.4	0.4
Pole-Line Hardware	0.5	0.5	0.5	0.4	0.4	0.4	0.4
Fencing	1.7	2.0	2.2	1.9	2.0	2.4	1.6
Other n.e.s.	4.3	4.4	4.3	3.1	3.2	3.6	2.4
Sub-total	37.5	40.6	40.7	38.2	39.7	43.2	40.8
Brass and Bronze							
Sheer, Strip & Plate	7.3	7.8	7.0	8.0	7.0	6.7	6.3
Rod and Wire	4.2	4.5	3.6	4.8	4.0	4.5	5.0
Tube	0.7	0.8	0.8	0.7	0.5	0.6	0.7
Casting and Billets	0.4	0.3	0.3	0.4	0.4	0.4	0.3
Copper-Base Ingots	0.5	0.6	0.7	0.7	0.8	0.6	0.6
Other Copper-Base Products	0.0	0.1	0.1	0.1	0.1	0.7	0.8
Sub-total	13.1	14.1	12.5	14.7	12.8	13.5	13.7
Zinc Base Alloy							
Die Casting Alloy	39.8	33.9	35.7	37.0	35.9	32.9	27.5
Dies and Rod Alloy	0.0	0.0	0.0	0.1	0.1	0.1	0.0
Slush & Sand Casting Alloy	0.8	0.3	0.4	0.6	0.7	0.7	0.5
Sub-total	40.6	34.2	36.1	37.7	36.7	33.7	28.0
Other Uses							
Rolled Zinc	2.7	3.1	3.0	2.6	2.7	2.4	2.2
Zinc Oxide	4.1	5.1	4.2	3.4	3.9	3.5	3.5
Other Uses[a)]	2.0	2.9	3.5	3.4	4.2	3.7	2.9
Sub-total	8.8	11.1	10.7	9.4	10.8	9.6	8.6
Undistributed consumption	-	-	-	-	-	-	8.9

a) Includes zinc used for zinc dust, wet batteries, desilverizing lead, light-metal alloys and other miscellaneous uses.

to produce lighter cars. The impact of lighter cars was more significant than the decrease in galvanizing resulting from both a depressed automotive and a depressed steel industry. This means that, in a highly industrialized economy, the importance of zinc in die-casting is on the decline. All other uses are relatively stable and consistent, at least within the period 1972 to 1978. Even the various sub-categories do not show any unusual trend. The importance of both rolled zinc and zinc oxide follow unabatedly and without major variations the trend of general industrial demand. Consequently, galvanizing in the U.S.A. will be more important in the future than die-casting alloys, while brass and bronze and rolled and oxide zinc will remain as important as ever. However, it should also be clear that this zinc input picture of a normal and highly industrialized country may be substantially different from that of an essentially militarily oriented country such as the U.S.S.R., which has a 50 percent higher output of crude steel than the U.S.A.[6]

SECTION III: ZINC PRODUCTION

This section investigates the world output of mined zinc and the role which Canada and Ontario played on this scene. Thereby, considerable interest can be raised seeing the Canadian and Ontario position in light of the major zinc producers in the world for a number of selected years. Furthermore, the zinc smelting and refining capacities of the world and of its producing and using countries will be comparatively scrutinized, while at the end of the section the Canadian zinc trade in international markets will be observed.

World and Canadian Zinc Ore Production

The world output of mined zinc rose from 2,274,000 metric tons in 1950 to 6,264,000 metric tons in 1979, or by a factor of 2.75. This more or less continuous rise has been shown in Table 4, which also indicates the way in which Canada's zinc mine production has fared during this period. Her zinc output climbed also during this time, though at first more quickly until 1970, after which it remained relatively stable. From 284,200 metric tons in 1950, it achieved a height of 1,239,200 metric tons by 1970; this was an upward change by a factor of about 4.3 which is almost twice the rate of the world over that period (2.43). After the year 1979, it stopped increasing and,

Table 4

World and Canadian Zinc Ore Production and Canada's and Ontario's Shares for the Years 1950 to 1979

Year	Zinc Output '000 metric tons World	Canada	World Production Share (in percent) Canada	Ontario
1950	2274	284.2	12.5	0.000
1951	2410	309.5	12.8	0.000
1952	2638	337.3	12.8	0.010
1953	2760	364.5	12.7	0.003
1954	2710	341.5	13.2	0.025
1955	2915	393.1	13.5	0.048
1956	3090	383.4	12.4	0.036
1957	3145	375.3	11.9	0.326
1958	3040	385.6	12.7	1.379
1959	3040	359.3	11.8	1.3
1960	3380	390.1	11.5	1.3
1961	3500	402.0	11.5	1.4
1962	3640	455.4	12.5	1.7
1963	3680	451.0	12.3	1.7
1964	4070	662.2	16.3	1.7
1965	4360	826.4	19.0	1.4
1966	4520	949.8	21.0	1.8
1967	4900	1133.1	23.1	5.6
1968	5030	1155.1	23.0	6.9
1969	5330	1194.2	22.4	6.7
1970	5530	1239.2	22.4	6.3
1971	5330	1133.7	21.3	6.2
1972	5500	1128.7	20.5	6.6
1973	5670	1226.6	21.6	7.3
1974	5600	1127.0	20.1	7.8
1975	5470	1055.2	19.3	6.1
1976	5520	982.1	17.8	5.7
1977	5750	1054.5	18.3	5.1
1978	6226	1066.7	17.1	4.2
1979	6264	1148.3	18.3	4.4

at one time, even levelled off to 982,100 metric tons in 1976. Over the next three years, it rose again to end with 1,148,300 metric tons in the year 1979.

Canada and Ontario as World Producers

The significance of Canadian output as a world zinc producer is expressed by the size of the market shares which Canada succeeded in capturing from 1950 to about 1968. At first, Canada had a 12.5 percent hold on world zinc output which it maintained until the year 1963. From then on, it started to climb until 1967, when the contribution by this country to the world zinc production accounted for 23.1 percent, a tremendous accomplishment. However, this position slowly eroded and by the end of the period under discussion, Canada's zinc production share stood at only 18.3 percent; still, the world zinc producer of prime importance.

However, something happened in 1967, which, fortunately, was to reflect favourably on the summary Canadian picture and added much to the pride of Ontario's mining industry! In 1967, the Province of Ontario with its zinc mines entered the field, rising from relatively unimportant position of 0.0 percent in 1950 and 1.8 percent in 1966 to 5.6 percent in 1967 and eventually to 7.8 percent in the year 1974. By world standards, Ontario by itself, had become a very important zinc producer. Nonetheless, this meant that zinc outputs in the

other Canadian provinces had fallen back dramatically.[7] Over the remainder of the period, Ontario's performance reflected the Canadian production conditions: output remained relatively stable and a decline in significance set in.[8]

Distribution by Main Producing Countries

The importance of Canada-and Ontario-may be seen in comparison to the other zinc mining countries in Table 5. Tracking back from 1979, it is clear that Canada is the number one zinc producer of the world, closely followed now by the U.S.S.R. Australia was the third and Peru in fourth place. At this point, Ontario could be inserted in the sense that it alone contributed more to the production of zinc than the United States of America; early in the 1970s, Ontario was as large a zinc producer as was Peru.

When viewing the position of the various countries in the year 1950, it is surprising to find the United States very much in front with almost a quarter of world zinc mined going to this country.[9] Canada held second place, followed by Mexico and Australia. In the year 1955, the U.S.S.R. took up the next position with 7.4 percent. As a matter of fact, 1955 allows for a more relevant comparison since the data for the U.S.S.R. had become assessable in a more reliable form.

It is interesting to note that Mexico lost substantially as a world zinc producer whereas the country of Peru made

Table 5

World Zinc Ore Production (Metal Content) and Distribution by Main Producing Countries for Selected Years between 1950 and 1979 in percent

	Years						
World Production ('000 metric tons)	1950 2274	1955 2915	1960 3380	1965 4360	1970 5530	1975 5470	1979 6264
Australia	8.8	8.9	9.5	8.1	8.0	9.3	8.3
Bolivia	0.9	0.7	0.1	0.3	0.1	0.9	0.7
Brazil	-	-	-	-	0.3	0.6	0.8
Bulgaria	-	1.4	2.3	1.8	1.4	1.5	1.4
Canada	12.5	13.5	11.5	19.0	20.5	19.3	18.3
China	-	-	2.4	2.3	1.8	1.8	2.4
Finland	0.3	0.8	1.5	1.8	0.7	1.0	0.9
West Germany	3.1	3.2	3.4	2.5	2.4	2.1	2.0
Greenland	-	-	0.3	-	-	1.7	1.3
Iran	-	-	0.3	0.3	1.1	1.2	0.6
Ireland	-	0.1	0.0	0.0	1.6	1.2	3.3
Italy	3.8	4.1	3.9	2.6	1.8	1.4	0.9
Japan	2.3	3.7	4.6	5.1	5.3	4.6	3.9
North Korea	-	2.0	2.5	2.4	2.4	2.9	2.3
South Korea	-	-	-	0.2	0.5	0.8	0.9
Mexico	9.8	9.2	7.8	5.2	4.8	4.2	3.8
Peru	3.9	5.7	4.7	5.8	7.0	8.2	7.8
Poland	-	5.9	4.3	4.2	3.5	3.5	3.5
Spain	2.7	3.2	2.5	0.9	1.6	1.6	2.2
Sweden	1.6	2.0	2.2	1.8	1.8	2.0	2.6
U.S.S.R.	-	7.4	11.1	10.8	11.8	12.6	16.6
U.S.A.	24.9	16.0	11.7	12.7	8.2	7.8	4.2
Yugoslavia	2.1	1.9	1.7	2.1	1.8	1.9	1.8
Zaire	2.2	2.3	3.2	2.7	2.0	1.4	1.0
Zambia	1.0	1.0	1.2	1.1	1.2	1.2	0.4
	79.9	93.0	92.7	93.7	91.6	94.7	91.9

strong inroads into the zinc area. Other countries, such as Japan and Poland, whose significance has somewhat declined, are countries which have to be reckoned with. This holds even more so for Ireland after the opening-up of the Navan deposit.

Bulgaria, West Germany, Italy, Spain, Sweden and Yugoslavia can be considered medium-sized producers, as each produces almost more than 1.5 percent of the world total. The country of Zaire could also have been included in this tally had it not been for the fact that its share, originally amounting to 3.2 percent (1960), had been substantially reduced to a mere 1 percent in 1979.

Zinc Capacity of Producing and Consuming Countries

Considering the rise of zinc consumption in the world over the period under study, a brief glance at the smelting and refining capacities is now in order. The capacities of both mine-producing and so-called 'end-user' countries will be studied briefly. However, the list is not complete - e.g. the U.S.S.R. is not included - and the accompanying Table 6 is merely to illustrate the critical change on the zinc smelting and refining scene which took place between 1950 and 1979.

On top of the list is the United States. Its basic smelting capacity was reduced by 16.5 percent or by roughly

Table 6

Zinc Treatment Capacities, Electrolytic Refinery Capacities and Smelter Capacities for the Years 1950 and 1979 in '000 metric tons

Country	Electrolytic Refinery Capacity			Smelter Capacity in Zinc '0		
	1950	1979	% Δ	1950	1979	% Δ
U.S.A.	338.4	319.3	-5.6	593.0	495.0	-16.5
Canada	199.4	645.	223.5			
Mexico		95.2	-	54.4	107.0	96.7
Argentina	4.0	25.9	547.5		16.0	
Brazil		52.5	-			
Peru	11.9	68.6	476.5	23.7	?	
Austria		25.0	-			
Belgium	30.0	203.0	576.6	301.1	145.	-51.8
Finalnd		160.0	-			
France	38.0	294.8	675.8	70.9	258.0	263.9
W. Germany		265.2	-	172.0	210.0	22.1
Italy	44.0	195.0	343.2	9.0	70.0	677.
Netherlands		160.0	-	35.0	?	-
Norway		84.4	-			
Spain		260.0	-	35.5	?	-
Yugoslavia		56.2	-	16.0	20.0	25.
India		90.4	-			
Japan	57.6	631.2	995.8	41.6	539.1	1196.
Zaire		69.9	-			
Zambia		15.3	-		34.9	-
Australia		250.0	-		68.0	-
U.K.			-	82.0	100.0	22.0
Poland			-	181.2		-
Czechoslovakia			-	23.0		-
World	723.3	3966.9	448	1638.4	2063.	25.9

Source: ABMS. op. cit. 1979, and prior publication.

100,000 metric tons. This is, of course, surprising considering that the U.S.A. is the largest consumer of the metal and that it could be expected, as the industrial giant which it is, to feasibly look after its own needs. On the refining side, the picture is likewise discouraging, although the decrease is of minor significance. Yet, the signs for both activities are negative!

Another country with a relative decline in smelting capacity is Belgium. This may be explained in that there is less demand for smelting ores, especially in a country which does not mine any zinc at all. Turning one's view towards the refining side, it becomes immediately clear that Belgium has gained much more in refining capacity which delivers the refined zinc than it lost on the smelting side. This means only one thing: this country is only interested in importing ores and concentrates for smelting and, particularly, for refining purposes. In this way, its own input needs are satisfied while at the same time, Belgium becomes an important supplier and competitor on the world market of refined zinc!

When proceeding to other European countries, the general trend becomes all the more obvious. Smelting and refining capacities have increased beyond what would be feasible on the base of zinc mining output and the domestic consumption demand of these countries. Zinc smelting and refining has become market-oriented with strong reliance on imported ores from

other countries. The European countries besides Belgium are: Austria, Finland, France, West Germany, Italy, the Netherlands, Norway and Spain, all of which, with the exception of the Netherlands, are zinc ore producers though many are insufficient to satisfy their own domestic zinc requirements. In the Far East, there is one country that excels by having taken first place in the combined smelting and zinc refining capacity competition. Japan increased both smelting and refining works over the period under study - the former rose by a factor of 13 (times) while the latter increased by a factor of 11 (times). If this mineral-economic success of Japan does not tell a tale, what then can? We may even go one step further. Look at the mining countries such as Australia and Peru. Both have firmly established themselves as zinc refiners exporting increasing amounts of the metal in competition with the other suppliers of refined zinc in the world market such as the European countries and Japan. Canada, to come to the point, has faired much better than the United States[10] as her refining capacity rose substantially. However, in comparison to the capacity expansion registered by the other industrialized countries, as brought out in Table 6, Canada has not performed as well as it could have. This raises a very serious question as to the zinc industry: Canada, quo vadis?

Canadian Zinc Trade

Canada is a net exporter of zinc. As a matter of fact,

the import of zinc substances to their exports stand at a ratio of 1:100. This may be seen from the summary Table 7 and, in detail, from Tables A1 to A9 in the Appendix to this Chapter.

Given the three years 1977 to 1979 as a background, our exports amounted to between 875,680 metric tons and 1,150,187 metric tons. Compared to our mining output, we export approxi-

	'000 metric tons	
	Mine Production (Table 4)	Exports (Table 7)
1977	1054.5	875.7
1978	1066.7	1150.2
1979	1148.3	1048.9

mately 95% of what we mine. Our own needs were:

	'000
1977	144.
1978	162.1
1979	172.3

amounting to about between 14 and 15 percent of mining output which can easily be supplied by the unexported portion of mine and refinery production, plus the 1.0 imports and other, secondary sources.[11]

Another interesting point in Table 7 is the proportion of ores and concentrates exported versus all exports. In 1977, almost two-thirds of our exports took the form of raw materials and only one-third was in refined form (zinc blocks, pigs and slabs). By 1979, this structure had changed somewhat in favour of the refined metal as about 40 percent of our zinc exports fell into this category, while ores and concentrates had been slightly reduced to 60 percent. Whether this trend is to continue is a question which cannot be answered. Without dwelling unnecessarily

Table 7

Canadian Zinc Export and Import Structure for the Years 1977-1979

by Commodity Items in metric tons

Commodities

	Commodity Item #	Exports			Imports		
		1979	1978	1977	1979	1978	1977
Volume in metric tons		1,048,910	1,150,187	875,680	14,163	10,140	11,113
		%	%	%	%	%	%
Zinc in Ores and Concentrates	257-10	57.06	59.66	63.45	-	-	-
Zinc, Zinc Alloy Scrap, Dross Ashes	257-39	1.47	1.67	2.19	-	-	-
Zinc in Ores, Concentrates and Scrap	257-99	-	-	-	69.67	60.60	54.42
Zinc Dust and Granules	457-04	0.35	0.37	.40	2.15	2.68	1.40
Zinc Blocks, Pigs and Slabs	457-08	40.93	38.19	33.73	-	-	-
Zinc Slabs, Blocks, Pigs and Anodes	457-10	-	-	-	18.16	23.72	29.95
Zinc Bars, Rods, Plates, Strip and Sheet	457-30	-	-	-	3.30	3.81	3.90
Zinc Slugs, Discs and Shells	457-32	-	-	-	0.52	0.15	0.08
Zinc Fabricated Materials. N.E.S.	457-49	0.18	0.11	0.23	6.19	9.04	10.25
		99.99	100.00	100.00	99.99	100.00	100.00

on the relatively unimportant zinc imports and their structure, a short analysis of our zinc customers should be undertaken. Who imports our ores and concentrates? According to Table A1 (Appendix) the answer is: Belgium, Japan, the U.S.A. and West Germany absorb over 80 percent of our ores and concentrates.[12] (1977 = 85%, 1978 = 81%, 1979 = 86%) Of course, these are the most important customer countries. Naturally, there are several other customers which we supply but their shares are not as important. As a matter of fact, we even export ores and concentrates to the U.S.S.R.! The same Table shows that in 1977 - 3 percent, in 1978 - 1 percent and in 1979 - 2 percent of this export category went to the Soviet Union. As to zinc alloy scrap and dross ashes, the two main buyers were the U.S.A. and the U.K., absorbing between 92% (1977) and 84% (1978) of that material. This has been set out in Table A2.

When considering the main customer countries for our refined zinc materials, only two come into focus: the U.S.A. and the U.K., absorbing between 71 and 80 percent of zinc in the forms of blocks, pigs and slabs.

Even if imports are unimportant, it is nonetheless interesting to see that we import zinc ores, concentrates and scrap from Bolivia, Peru and the United States. This has been set out in Table A3. In the same context, we have to recognize that Canada imports a small quantity of zinc slabs, blocks, pigs and anodes with Peru (1979 = 91%), the U.S.A. (1978 = 34%;

1977 = 26%), China (1977 = 22%) and the Netherlands (1977 = 18%) as the chief material sources. The imports of fabricated zinc materials, as tabulated in Table A9, come mainly from the U.S.A. and the U.K. In essence, all zinc imports are of minor significance, but still serve as an interesting source of information.

SECTION IV: WORLD RESERVES AND ALTERNATIVE SUPPLIERS

The following exposition discusses at first the problem of world zinc reserves and their distribution. Afterwards, attention is directed towards the activities surrounding the zinc industry and its potential in the main supplying countries. The countries investigated are:

U.S.A.	Peru
U.S.S.R.	Australia
Mexico	Poland
China	Other countries (Tunisia,
South Africa	Thailand, India)
Chile	

World Reserves

Here again is a problem which is difficult to solve. Essentially, we are concerned with minerals of a quality to be an economic ore feasible for extraction. If prices are rising faster than cost of recovery, the ore reserves increase; and since we are looking 25 years into the future with rising prices, there is no doubt that the zinc reserves will rise! Eventually, undiscovered resources will be discovered and known, uneconomic minerals will become ores. It is just as simple as that!

How much zinc is there in store? Disregarding the problem of reliability of the figures, there are three different types of answers. One estimate has it that within the first, outer kilometer of the continental crust which covers just one-third of the earth, 52,000,000,000,000 tons of zinc are embedded.[13]

This is a statement of the size of the mineral occurrence. The second question has to do with zinc deposits of a higher degree of concentration which eventually may become classifiable as ores. They consist of 1,275,000,000 metric tons of known uneconomic deposits and those resources which may be either economic or uneconomic but are still uneconomic. This total is, according to Rachamalla and Bell,[14] 5,085,000,000 metric tons, of which 345,000,000 should be economic and, thus, minable; and thirdly, there are the known reserves which amounted to 245,000,000 metric tons for the years 1973/74 in one publication,[15] 235,000,000 metric tons in another (1977).[16] The minimum of known deposits as of December 31, 1979 would amount to 215,770,000 metric tons; a figure which takes account of the mined zinc of 29,230,000 metric tons since 1975 inclusive, but does not allow for newly discovered zinc resources. The point next to arise concerns the way in which they are distributed among countries. The answer is summarily presented in Table 8 which demonstrates quite effectively that the three countries of North America hold 41.1 percent of world zinc ores. As individual countries, Canada is the single most important holder of zinc reserves with 20.4 percent of the total, followed closely by the United States with 18.5 percent.

Next in line is Australasia with 13.3 percent, followed by the U.S.S.R. with 8.9 percent - for a summary total of 63.3 percent for these five countries. Having already included Mexico

Table 8

Total World Zinc Resources of Proven Mining Districts

By Main Supplier

World (in '000,000 metric tons)	245.0	Percentage
U.S.A.		18.5
Canada		20.4
Mexico		2.2
Central America		0.7
Peru		2.2
Brazil		2.6
Other		1.9
Ireland		4.4
Poland		2.6
U.S.S.R.		8.9
Yugoslavia		2.2
Other Europe		5.6
Zaire		1.5
Zambia		0.7
Other Africa		3.3
China		1.9
India		1.1
Japan		3.0
North Korea		1.1
Other Asia		1.9
Australasia		13.3
		100.0

with additional resources discovered in the United States, Canada, Australia and South Africa.

Identified metal content is 1.8 billion tons with another 2.5 to 3 billion tons as a by-product of coal.

in the tally so far, there is a small number of other significant zinc holders. They are: Ireland (4.4%), Japan (3.0%), Poland (2.6%), Brazil (2.6%) and Peru (2.2%), with a cumulative total of 78.1 percent.

However, it has to be pointed out that these figures are open to question and have to be seen as extremely rough indicators. The experts in the field have presented somewhat different reserve quantities, but they have also pointed out the difficulties surrounding reserve estimates. They have warned especially against placing too much emphasis on these figures in evaluating the consequences. Dennis Meadow's Limits to Growth - the famous publication of the Club of Rome - fell into this reserve trap.[18] The figures should be used here with circumspection.

The Alternative Suppliers of Zinc

U.S.A.

1979: 263,700 metric tons 1950: 565,500 metric tons

In the year 1979, the United States mined 263,700 metric tons of zinc, which marks the continuation of its decline in zinc mining output. This stands in contrast to a consumption of slab zinc of 1,008,170 metric tons for the same year. When exports and imports of zinc in various forms are taken into account, it is quite surprising to find the United States of America to be dependent on the imports of zinc by over 60 percent. The amount of recycled zinc corresponds to about 3 percent of the total

zinc produced.

The import sources of the United States of zinc ores and concentrates are: Canada with 57 percent, Honduras with 11 percent, Mexico with 9 percent, and 23 percent taken up from other countries. Zinc imports in refined form come from Canada (44%), Mexico (7%), Spain (7%), and from West Germany (6%). Various other countries contributed for the remaining 36 percent.

There are five major zinc mines in the United States which mine 55 percent of total output. Industrial concentration is such that the 25 leading zinc mines produce 97 percent of all U.S.A. zinc ores. The major producing states are: Tennessee (31%), Missouri (23%), New Jersey (12%) and Idaho (12%).

The United States imposes a tariff on all zinc products, either as a unit tariff or as an ad valorem impost.[19]

As to the investment plans of American corporations, the outlook is not very encouraging. Initially, Exxon Minerals had plans for an underground mine to produce 3.17 million metric tons of ore per annum. This mine was to be located at Crandon, Wisconsin, requiring an initial investment of $500 million and should have been in operation by about 1987.[20] However, this planned expansion has been put on hold for a variety of reasons. Furthermore, even a new copper-zinc test mine at the Pinos/Altos deposit near Silver City, New Mexico, has been discontinued by the same company.

Only St. Joe Minerals is opening a new zinc mine in Pierrepont, N.Y., with an approximate annual capacity of 114,000 metric tons of ore. The general picture does not speak much for a change in the general direction of the zinc mining industry yet. The U.S.A. will remain dependent on imports for quite a period of time.

U.S.S.R.

1979 Production: 1,039,600 metric tons; consumption: 990,000 metric tons.

1950 Production: 164,000 metric tons; consumption: 142,000 metric tons.

After Canada, the Soviet Union ranks now second as a producer of zinc in the world. Like Canada, the U.S.S.R. is a net exporter of zinc which amounted to 100,000 tons of unwrought zinc annually. The U.S.S.R. imports zinc ore (60,000 tons)[21] and unwrought, unalloyed as well as alloyed zinc (64,000).

The domestic sources of supply are the same as for lead with which it occurs in complex ores. Kazakhstan is the leading zinc (and lead) producer, with the Ural mountains, Uzbekistan, the North Caucusus and the Ukraine as the next important supply areas.

The production of zinc in Kazakhstan increased by 80% between 1967 and 1976 with further expansion of production scheduled.

Certain reports from the U.S.S.R. state that production quotas in the year 1978 were not met either through shortages and in the form of a low quality of concentrates supplied by several concentrating plants. Nonetheless, there is no denying the fact that zinc output of the U.S.S.R. has risen spectacularly and had the so-called production plans been fulfilled, then the output would have been even more "spectacular"! However, one can point to certain difficulties which the U.S.S.R. has in the zinc sector. Of considerable urgency to the officials of the U.S.S.R. is the opening-up of ore deposits of the Altay region in East Kazakhstan. The reason is that over the long period that the output of zinc increased, the grades have dropped. Over the past ten years, the output of polymetallic ores has increased by a factor of four. Considering also that the U.S.S.R. - according to Table 8 - has only 8.9 of the world's zinc reserves (Duncan places it at a mere 5 percent) and that the U.S.S.R. mines 16.6 percent of the world total - Table 5 - then it does not surprise that such difficulties arise.

It is also mentioned that the output of the Zyryanovsk complex increased by 20 percent whereas the grade of ore decreased by 25 percent. The general argument is that overall shortage of ores will materialize in the future which will manifest themselves by a zinc output below planning targets for the period of the Eleventh Five-Year Plan 1981-1985. This situation may be

improved with the beginning of mining operations of the Nikolayevsk open-pit mine, by the processing of metalurgical wastes as undertaken by the Ust'Kamenogorsk lead-zinc complex, by the utilization of dust and slags of the Pyshminsk and Irtysch copper smelting plants and of cakes and clinkers from the Ust'Kamenogorsk zinc shop in addition to slags from old dumps. In the Ural mountains, the copper-pyrite ores seem to cause problems in the recovery of zinc while slow development of mines in the Ural and shortages in the deposits at Sadonsk in the Northern Caucasus - the main supplier for the electrolytic zinc plant in Ordzhonikidze - do not help to alleviate the situation.[23] If these reports correspond closely to the true situation, then, it is possible that the U.S.S.R. may encounter a significant shortage of zinc which is bound to get worse, unless important new deposits are discovered.

Mexico

Mexico's mineral fame stems from the production of gold, silver, lead and zinc. However, in the previous two decades, that fame subsided substantially. In 1961, a law was passed to bring all Mexican mines under national majority ownership. This process of Mexicanization has had serious repercussions as it slowed down the development of the Mexican mining industry. Its growth rate fell to 3.4 percent whereas that of the country's

gross national product averaged 6.1 percent annually.

When President Lopez Portillo took office, he announced a general plan for the mobilization of the Mexican industry. In the context of this revitalization scheme, the Mexican mining industry committed itself to invest the until then unheard of amount of $2.2 billion. This amount was more than had been invested under the two previous presidents together. Under President Dias Ordaz (1964-70), $80 million went into the mining industry while under the more expansionist President Echeverra (1970-76), $1.6 billion were invested in the mining sector.

The following allocation was specified.

Exploration	$105 million
New Projects	$654 million
Modernization	$119 million
General Projects	$310 million

The intention was also to diversify the industry because it had been recognized that, in the face of Mexico's general industrial development, the mining industry was not delivering the proper mix of metals and minerals for the given input structure of the Mexican economy.

Some very interesting projects were set into motion which will not fail to improve the mining performance, especially in the zinc areas.

The firm Industrial Minera of Mexico is building a zinc refinery in San Luis Potosi with a planned capacity of 113,000 metric tons annually which would more than double this country's refinery capacity by bringing it up to 208,000 metric tons.[24] This refinery, which will cost $150 million, will be on stream in 1981. The same company is investing another $49 million to increase its zinc-copper ore output from 1250 to 6800 metric tons per day. This mine is located at San Martin, Zac., with a recorded ore grade of 5.3% zinc, 1.24% copper and 146 grams of silver per metric ton. This project will be in operation in 1982. The same company is investing a further $60 million to increase its mining and concentrator capacity from 2700 to 5200 metric tons per day. This expansion takes place at a mine in Santa Barbara, Chi., with a recorded ore grade of 4.7% zinc, 2.6% lead, and 0.65% copper and an additional 140 grams of silver per metric ton. The underground concentrator at another mine of the same company in Taxco, Guerrero, which has a slightly leaner ore than the Santa Barbara mine, will undergo a capacity improvement from 2200 to 3300 metric tons per day. Both projects are to be completed by the year 1981.

The firm Industras Penoles is investing $26 million in a mining and concentrator project which will deliver 40,000 metric tons of zinc concentrate. The location of this project is at La Minita, and the Fresnillo Company is spending an undisclosed amount in a shaft-sinking and mill modernization

project which will increase the lead and zinc ouptut from 2500 to 3000 metric tons per day. The mine location is in Naica, Chi. This means that the zinc (and lead) industry of Mexico has committed over $280 million mainly to raise its output potential.

China

China has been suffering from shortages of zinc and lead. Given its approximate output of about 100,000 metric tons of zinc per annum, this shortage can only be remedied if more deposits are developed, more mines opened up and more smelters constructed. In the present atmosphere of intense modernization, the shortage will be felt even stronger as the consumption of zinc is expected to climb to 300,000 metric tons annually. China never claimed to be rich in zinc but the discovery of new deposits and continuous and extensive exploration have been underway for some time and have not failed to produce results.

It cannot be said that the available information is in a summary form, consistent, conclusive or complete. However, certain observations have been made, some of which should be recorded here to leave an impression that more is known about China and its zinc potential than is publicly believed.

China has an estimated ore reserve of 50 million metric tons of contained zinc,[25] which is considerably larger than the earlier estimates as presented in Table 8 or the 1.8 million

tons noted by Duncan R. Derry.[26] This represents a phenomenal increase over previous estimates and reflects definitely the determination of that country and its 600,000 geologists to solve an urgent resource problem. However, sufficient ore deposits alone are not enough for such a solution. A huge amount of capital is required to utilize the ore. This requires smelters and refineries.

Following Japanese reports, China has a number of smelters. The Shenyang smelter in Liaoning has a capacity of 15 - 20 thousand tons, while the Zhuchou smelter is able to produce as much as 120 thousand tons. The Chinese are highly interested in improving the operations of these smelters by modernizing the equipment, including adequate pollution control devices, in order to expand production. A license has also been issued for the construction of a 35,000 tons zinc and 18,000 tons lead smelter. This smelter will be located twenty miles north of the famous Fankow mine in Kwangtung. The Imperial Smelting People will be in charge of the project.

Recently, the Mitsubishi Metal Corporation of Japan has been asked by the Chinese to investigate the feasibility of opening three large lead-zinc deposits in

a) Qsinghai Province (Xitieshan),(also written: Tingsai Province, Sitieshan)

b) Gansu Province (Cheng Xiang), (also written: Kansu Province, Chengxian)

c) Sichuan Province (Huili), (also written: Szechuan Province)[27]

The project should include a combination of mining and smelting operations. However, nothing is recorded as to the size of these deposits, at least in the sources consulted.

Furthermore, the Toho Zinc Corporation, the second largest zinc refinery in Japan, has negotiated to build a 100,000 tons-per-annum zinc refinery for China at a cost of $160 million. This will be a very important and welcome addition in a country which apparently suffered from capital starvation of long standing.

This does not imply that there are no other facilities for smelting or refining of zinc. For instance, there is a 5000 tons-per-annum zinc smelter (10,000 lead) in Sungpei of the Hunan Province; likewise, there is a small smelter with the name of Liencheng in the Fukei Province. They may be quite old and antiquated, but, most of all, they are too small to meet the industrial consumption demand of zinc of China which is so intent on catching up with the industrialized countries of the world.[28]

South Africa

Production 1979: 51,250 (metric tons)

South Africa's zinc ores and concentrates come from only one mine: The Prieska Copper Mines Ltd. is a mine located 64 km southwest of the town of Prieska in the Northwest Cape Province. This mine was opened seven years ago and produced 68,660 metric tons in 1978 and 51,250 metric tons in 1979.

It is questionable whether it will remain the chief supplier of zinc as the mine has experienced ore reserve problems.[29]

In the year 1977, the Phelps Dodge Corporation and Gold Fields of South Africa, with a 49%:51% ownership distribution, agreed to develop the Aggeneys copper, lead and zinc deposit in the Black Mountain area of South Africa at a cost of $219 million. The production targets were set at

22,000 metric tons of copper concentrates
132,000 metric tons of lead concentrates and
35,000 metric tons of zinc concentrates

The average ore grade is 0.45% of copper, 0.625% of lead, 0.287% of zinc and 0.08% of silver.

The orebody has an estimated size of 200 million tons of ore of which 38 million tons are known. At 0.287% of zinc, this deposit would contain 5.7 and 1.1 million metric tons of zinc respectively. At a planned annual rate of 1.125 million metric tons of ore extracted, the definite lifespan of this mine would be thirty-four years, delivering annually 32,250 metric tons of zinc.[30] Considering the 1979 zinc mine production of South Africa which was 51,250 metric tons, this mine would increase the output by 63% over that year or by 46.9% over 1978. It will supplement South Africa's zinc production should the Prieska deposit face a more sudden depletion than expected.

A third lead-zinc deposit is at Gamsberg near Springbok. Plans existed for opening up this mine which would have cost $195.5 million. This project has been put off until the zinc

market improves considerably. The size of this orebody is substantial, comprising 143 million tons at a grade of 0.5% lead and 7.0(!)% zinc. If brought on stream, this complex could deliver between 182,000 and 350,000 metric tons of zinc annually. This deposit, owned by Newmont Mining, O'okiep Copper (each holding 27.5% of shares) and The Anglo American Corporation (holding 45%), could have an ore reserve of 10 million tons of contained zinc, which alone would account for much of the 15 million metric tons of South Africa's zinc reserves as stated by Duncan R. Derry.[31] This means that, if need arises, and the price has moved up sufficiently, this orebody could supply zinc for a considerable time.

Chile

In Chile, Toqui Mining has a new 35,000 metric ton-capacity concentrator on the drawing board. It would be built in Aysen, Chile and had been planned to start in 1981. No other important zinc project has been recorded for Chile.

Peru

The electrolytic zinc capacity of Centromin, as set out in Table 6, is 68,600 metric tons.[32] To this will be added another 101,500 metric tons of zinc through a refinery which is under construction at Cajamarquilla. It belongs to Minera Peru and will raise the refining capacity of this country by

148.1 percent, confirming, like Mexico, a general emphasis of the resource holdings countries towards self-refining with the aim of exporting zinc at a higher form of refinement than as ores or concentrates. In this position, a greater value-added component accrues to the domestic economies than is the case when raw materials - ores and concentrates - are exported

Australia

Production 1979: 521,160 metric tons; Consumption: 136,700 metric tons

Besides the improvement of several concentrators, no major zinc refinery project is recorded. However, new zinc mines are being opened up. The Electrolytic Zinc Company of Australia (EZ) is investing $180 million to start a new mine which will deliver 1.1 million metric tons per year from the Elura deposit near Cobar, N.S.W. This mine which has a known reserve of 27,000,000 metric tons and an ore grade of 8.5% zinc, 5.6% lead and 139 grams of silver per metric ton, will be in operation in 1982. The same company will also open up the Que River deposit on Tasmania's west coast with an expected rate of 150,000 - 200,000 metric tons of ore per year. The first deliveries from the Que River deposit are expected in 1981.

The development of the Hilton Mine, north of the famous Mount Isa orebody, is continuing. However, there is no mention when this mine will be in operation. In short, Australia is

looking forward to substantially enlarged zinc mining operations to feed smelters, refineries and to satisfy export demands of raw materials.

Poland

In Europe, the Government of Poland will increase its zinc ore capacity of all its mines from 6.6 million to 8.3 million metric tons of zinc ore between 1981 and 1985. This is equivalent to a 25.75 percent increase, as two new mines are planned for the Zarwiercie region. Other regions in which lead-zinc mines are located are Tarnowskie Gory, Olkusz and Charznow. The estimated reserves are about 350 million metric tons of ore. This development in the zinc mining field stresses the significance which Poland assigns to that particular industry.[33]

Other countries

Tunisia is another country which tries to increase its output of zinc. From an output of 22,000 tons per year, it is aiming at raising its present capacity of 31,000 metric tons to 52,000 metric tons by the year 1985 at a cost of $50 million.

In Thailand, it is the Thai Zinc Corporation which is ready to start the construction of a $120 million zinc plant. The objective is to produce 60,000 metric tons of zinc a year with the plant expected to be in operation by 1983.

India is known in the zinc industry through the state-owned Hindustan Zinc Corporation. It has a smelting capacity of about 95,000 metric tons which is not registered in Table 6. According to another source, the refining capacity of the HZL is 75,000 metric tons. New zinc discoveries - 21 million metric tons in Bhilwara, Rajasthan; 2.5 million metric tons in Gorubathan, Darjeeling; 1 million metric tons in Mamandur, South Arcot, Tamil Nadu, plus a large one-kilometer-long strike zone in Tambekhani-Kolari-Bhonri of Nagbur - testify to improvements in zinc potential. However, due to inflation and the international fuel crisis, shortages in fuel and transportation arose which, combined with a considerable credit squeeze, played havoc with the Indian economy and the zinc industry such that the total consumption for zinc of 108,000 metric tons was satisfied only by 50 percent from domestic sources. This is in spite of the fact that domestic production capacity could deliver 75% of domestic consumption.

SECTION V: FORECAST OF PRICES, SUPPLY AND CONSUMPTION OF ZINC

This section will, at first, examine the behaviour of zinc prices in the past before investigating their future into the next century. Subsequently, the future of the supply and demand of mined zinc will be analysed and, finally, a brief discussion of the consumption of slab zinc will follow. These results will be compared to the results obtained from other studies to consolidate the validity of the econometric analysis.

Zinc Prices

Historical prices

Following Schmitz, zinc prices in the second half of the 18th Century and in the early years of the 19th Century were on several occasions much higher than they were to be from about 1825. Schmitz presents these values with respect to Germany and the United Kingdom. When the metric ton of zinc cost 600 marks in 1823, the British price was £ 22 for the same amount. In 1759, the German price had been 1,320 marks, in 1800 it was 1,920 marks and in 1808, the peak price was 1,680 marks. British prices are not quoted for these years.

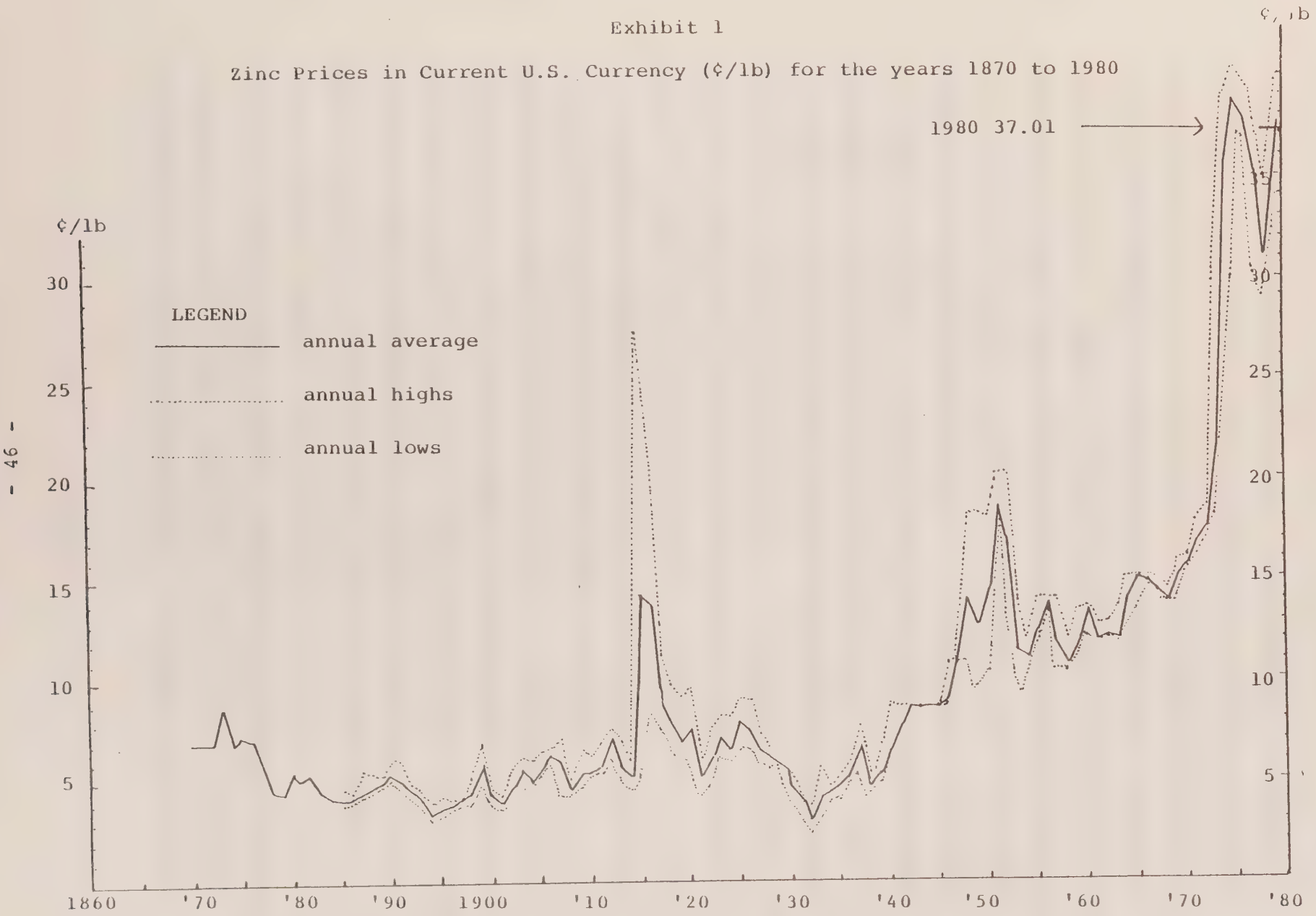
When the British prices of zinc are studied, it is interesting to note that they hardly ever rose above the value of

£22/metric ton until the year 1914. Of course, the prices dropped at times to less than half of that value, especially between 1829 and 1834. Only in 1841 (31.75), 1856-1858 (26.25, 27.50, 24.85), and in 1873 (25.76/t) and finally in 1906 and 1912 did the price reach the 26.64 and 25.75 pound marks respectively. Therefore, zinc prices, as quoted for Europe, had only been very high on the continent as reported for three years between 1759 and 1808, while, subsequently, European prices, especially those in Great Britain, remained almost stable until the beginning of the First World War.

The zinc prices in the United States reflected this stability which can be seen in Exhibit 1. Starting in 1870, the price was 7¢/lb. The price gently moved downwards to 3.52¢/lb. From then onward, it rose for a number of years until it reached 5.30¢/lb in 1914. During the years 1915 and 1916, it averaged 14.44¢/lb and 13.75¢/lb respectively with the corresponding highs of 27.50¢/lb and 21.18¢/lb. Afterwards, again the zinc price slipped and it reached a bottom in 1932 with 3.25¢/lb. From the depth of the depression, the price started to climb, reaching an average of 18.75¢/lb in 1951, with a high of 20.29. This time was marked by the Korean War. Afterwards, the price of zinc settled back somewhat but eventually it continued its rise which began in that depression, and it was only after 1972, when it had arrived at 17.73¢/lb that it ran away, reaching 38.89¢/lb in 1975. Subsequently, it dropped to 31.30¢/lb for the year 1978, only to bounce back to 37.30¢/lb

Exhibit 1

Zinc Prices in Current U.S. Currency (¢/lb) for the years 1870 to 1980



Source: The Statistical History of the United States from Colonial Times to the Present. Washington, 1962.
Neal Potter and Francis T. Christy, Jr., Trends in Natural Resource Commodities, Resources of the Future, John Hopkins, 1962; Engineering and Mining Journal.
A.B.M.S. Non-ferrous Metal Date, New York, N.Y,-1979
A.B.M.S. Year-book, 1951(1950)-

in 1979 and 37.01¢/lb in the following year (eight month average). This means that with the exception of war periods, the price of zinc had stayed relatively stable between 1825 and 1945. From then on, it started to climb and it accelerated especially after 1972.

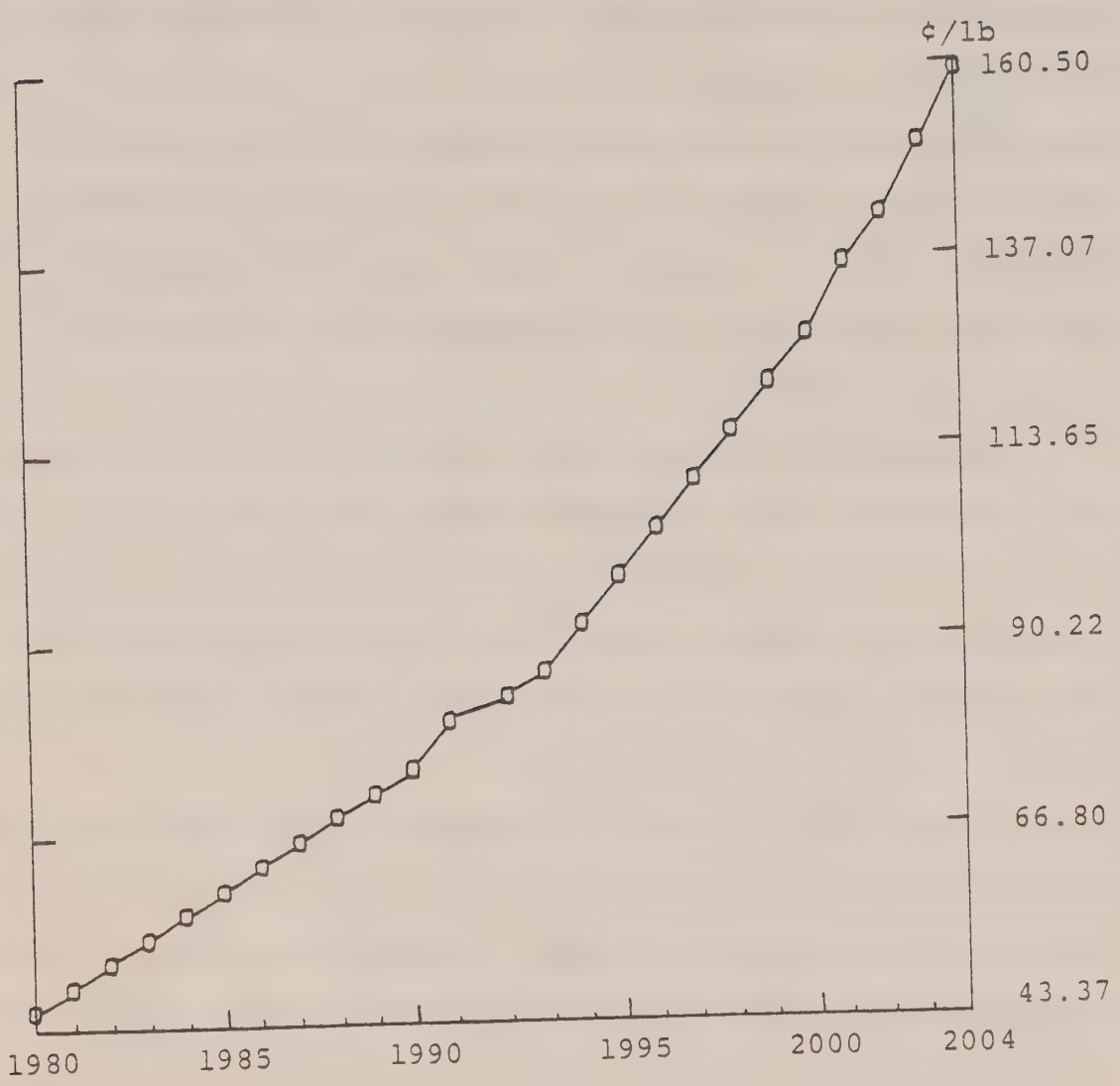
Future prices

Due to the continuously increasing volume of zinc consumption of the world, the price of this metal will likewise continue its climb in the years ahead. At first, the rate of increase will be small. From an estimated price for 1980 of 43.37¢/lb (constant 1979 U.S. currency), it will meet the 50¢/lb mark by 1982. Only in 1986 will it transgress the 60¢/lb limit. However, from then onward, the price movements will accelerate in the same upward direction. Following the econometric model, the year 1996 will see a price of a pound of zinc above $1 U.S. By the year 2000 - and this has been brought out in Table 9 and in Exhibit 2, as assumed in the econometric model, the price of zinc may even climb to $1.605 in the year 2004. It is, of course, understood that these projections of prices, and of the following supply and consumption of zinc are subject to the same qualifications as indicated in Chapter I and in the gold and lead chapters of this study.

Exhibit 2

Zinc Prices in Constant 1979 U.S. Currency

for the Years 1980 to 2004



Supply (= Demand) of Mined Zinc

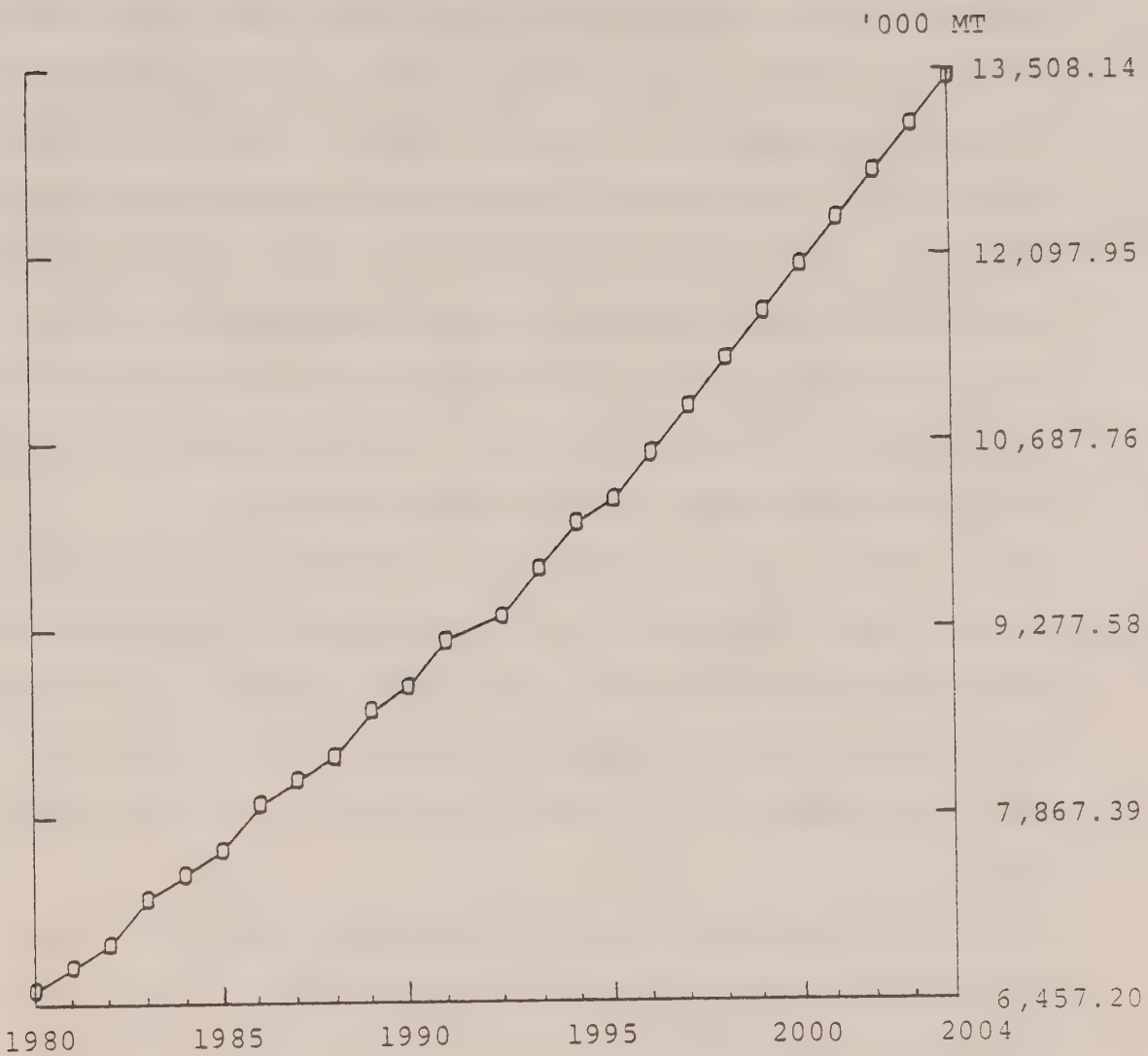
The projected mining output of zinc is given in Table 9 and is represented diagramatically in Exhibit 3. The mine supply of zinc will start from a base value of about 6.5 million metric tons in 1980. The rise will be more or less steady and in the year 1987, 8.1 million metric tons of zinc will have been extracted from the earth. In 1991, this annual quantity will exceed 9.1 million metric tons and by 1994, the 10 million metric ton mark will have been reached. For the year 2000, the zinc mining industry will record an output of almost 12 million metric tons annually, and provided the underlying assumptions hold, the year 2004 will realize a zinc production of 13.5 million metric tons.

Translated into the total amount of zinc mined between 1980 and the year 2000, it would appear that 189.2 million metric tons will have been absorbed by the mining industry. By 2002, it would be 214.2 million metric tons and, in the year 2004, 240.9 million tons would have been cumulatively mined over that period.

In addition, it has to be mentioned that the line of projected zinc supply, at least until the year 1996, shows varying slopes from one year to the next. These small changes in direction of the behaviour of projected zinc production may allow for the interpretation that greater swings in zinc output can be expected

Exhibit 3

World Zinc Mining Supply (= Demand) for the Years 1980 to 2004 in '000 metric tons



as indicated in the simulation study of zinc output in Figure 25 of Chapter I. This presentation will desist from following such an interesting temptation of projecting such swings!

Consumption of Slab Zinc

The consumption of slab zinc, starting from a base of almost 6 million metric tons in the year 1980, will reach a total of 7 million metric tons in 1986. By the years 1991/1992, it will have passed the 8 million mark. These values are set out in Table 9 and are also reproduced in diagramatic form in Exhibit 4. Around the years 2000/2001, zinc slab consumption of the world can be expected to have surpassed 10 million metric tons, and if the world economy performs as this model preassumes the consumption of this type of zinc will amount to 10.8 million metric tons in the year 2004.

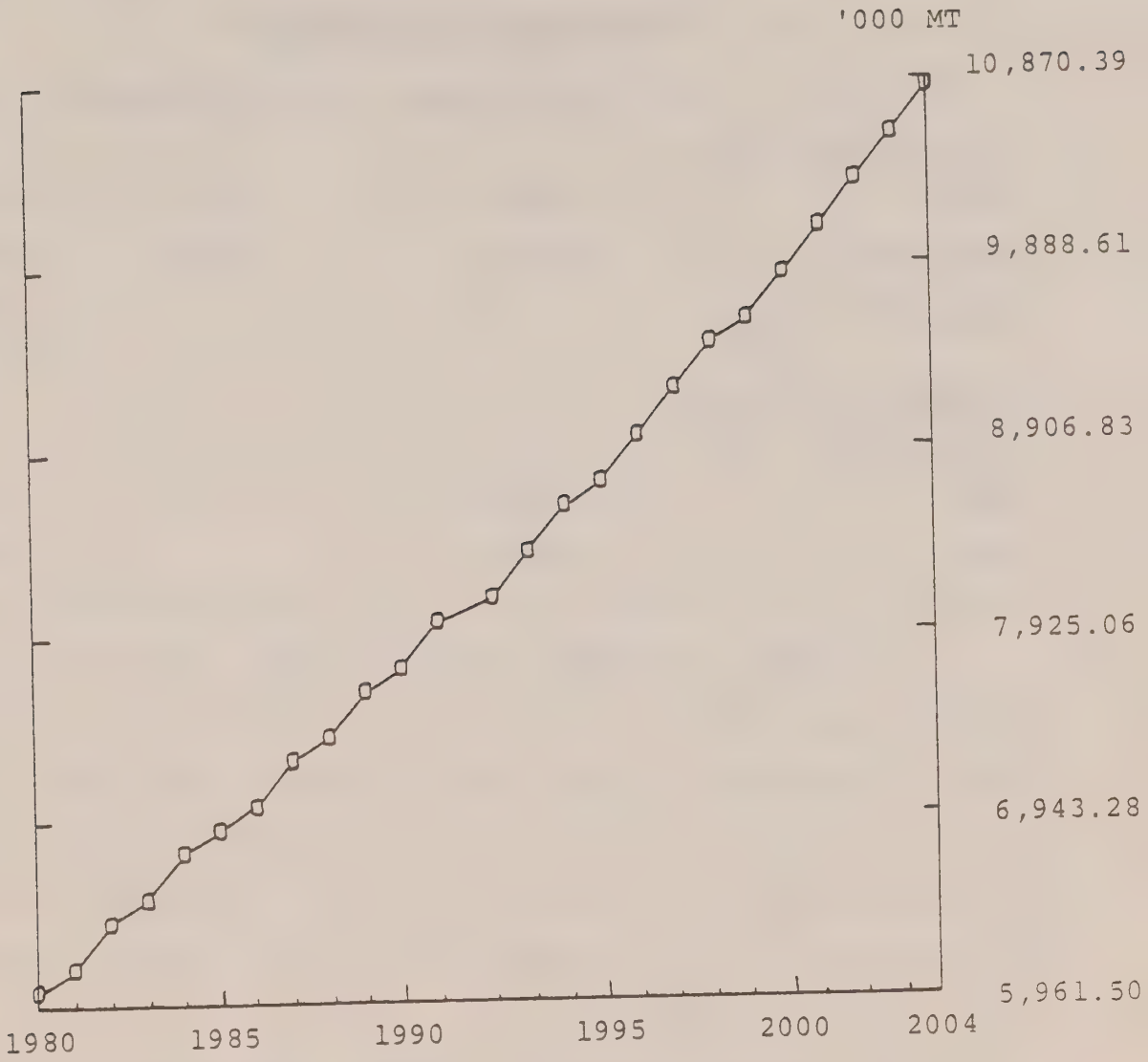
Fluctuations in this trend similarly to those noticeable for the supply forecast could be utilized in predicting fluctuations in industrial zinc slab input but also in assessing the possibilities of inventory changes in the years ahead. Again, no attempt will be made to follow up this interesting idea.

The predicted values of supply and demand for total primary zinc as well as for the consumption of slab zinc - equivalent to primary metal only - can be compared to

Exhibit 4

World Consumption of Slab Zinc for the Years

1980 to 2004 in '000 metric tons



predictions made in earlier years by two outstanding international authorities in the field. One of these forecasts was undertaken by Dr. Wilfred Malenbaum and occurred in October, 1977.[35] The other goes back to the year 1973, and was published by the U.S.B.M.[36] The following breakdown of all three predictions may serve as a base for comparison.

Comparison of Projections
in '000 of metric tons

Z I N C	Dr. E.T. Willauer	Dr. W. Malenbaum	U.S.B.M.
Total Primary Supply 1985	7,608	8,253	8,020
Supply 2000	11,994	12,022	11,204
Range 2000 - low			7,938
high			13,934
Consumption of Slab Zinc (primary metal consumption) 1985	6,836		7,076
2000	9,894		9,616

Although there appears to be a slight difference in opinion in the supply forecast for the year 1985 between this analysis and the projections by the other two authorities, this discrepancy disappears entirely for the projections for the year 2000 when comparing Dr. Willauer's and Dr. Malenbaum's forecasts. The magnitude is 28,000 metric tons out of 12,000,000 metric tons, or 0.2 of 1 percent.

The forecast values of slab zinc consumption undertaken in this study when seen against the primary zinc (metal only)

demand prediction of the U.S.B.M. are close and, thus, quite satisfactory especially since the slab zinc consumption values are consistently below the total primary zinc output figures.

SUMMARY AND CONCLUSION

World zinc consumption more than tripled during the period under investigation whereby the U.S.S.R. and Japan showed extraordinarily large absorption of zinc. The United States of America, still the largest consumer of zinc, and the United Kingdom, however, are now relatively less pronounced industrial users of zinc. Whereas industrially developed countries demonstrated a relatively equal and stable growth in their zinc consumption, the industrially advancing countries, besides the U.S.S.R. and Japan, displayed substantially improved performances through high rates of increases in zinc use.

In the highly industrialized countries such as the United States of America, zinc is now used for galvanizing more than for die-casting purposes as was previously the case; the other zinc uses in brass and bronze as well as rolled and other types of zinc did not reveal any significant change for a small number of years analysed.

World zinc mine production rose substantially between 1950 and 1979, but Canada, the world's largest producer, was able, for a number of years, to exhibit a higher growth of zinc output than the world as a whole. Eventually, the Province of Ontario became a zinc producer of world significance comparing favourably with such outstanding zinc suppliers as Peru and Mexico.

At one time, the U.S.A. was, by far, the largest zinc ore supplier of the world. However, by 1979, the Province of Ontario alone was more important than the U.S.A. in this area. Over the years, Mexico lost substantial ground while Australia maintained its position. In contrast, the U.S.S.R. has become the second largest supplier of mined zinc, while a small number of other countries are important as medium-sized producers.

In the smelting and refining field, the world industrial zinc consumers are building up their capacities relying heavily on the ores and concentrates of the zinc mining countries. However, Peru, Australia, and also Mexico are trying to increase their smelting and refining capacity. Canada has also expanded its refining capacity, though not quite as vigorously as other countries.[37] The United States, in contrast, has lost both smelting and refining capacities over this period.

Canada is a net exporter of zinc as about 95 percent of all mined zinc is shipped abroad. Of this amount, about 40 percent leaves the country in refined form while 60 percent are ores and concentrates.[38] However, there is a slight tendency for the share in the shipment of refined zinc to be on the rise as noticeable over the last three years. Belgium, Japan, the U.S.A. and West Germany are the main customers of ores and concentrates, while the U.S.A. and the U.K. are the main purchasers of our refined zinc. The Soviet Union has become a customer of the unrefined material, though on a small scale only.

Given the known and unknown economic zinc reserves of the world, with 215 and 325 million tons of zinc metal content respectively, Canada is known to be the largest holder of known zinc deposits (20-25%), followed by the United States of America (18-20%), Australia (13.3%) and the U.S.S.R. (8.9%). Opinions differ widely as to the exact distribution among countries.

Strangely enough, the U.S.A., with the second largest zinc deposits of the world is dependent on the import of zinc to a very high degree; in contrast, the U.S.S.R. mines a much larger proportion annually than it has reserves but still is a net exporter of refined metal due to its imports of raw materials. Mexico is investing heavily to regain part of the share which it lost in the world zinc picture by aiming at doubling its zinc refining capacity.

China has much larger zinc deposits than is generally recognized; they may be as large as Canada's. However, China urgently needs additional smelting and refining facilities. It will require large amounts of zinc for its own industrial consumption and would not appear to be a serious competitor in the world refined zinc market for a considerable period of time; yet, it could become an even greater exporter of ores and concentrates than it is right now.

South Africa has large reserves of zinc which will come on stream when market conditions permit. At a rate of 200,000 metric tons per annum, it could supply zinc for half a century.

Chile is expected to increase only its smelting capacity in the near future whereas Peru will expand refining facilities by 148 percent. In the light of the ore reserves of Australia, it is not surprising that this country will step up its zinc mining output. This holds also for Poland while Tunisia and Thailand will add both to their zinc capacities.

Following the econometric analysis, the prices of zinc will rise and will show a relatively strong performance such that by the year 1996, a pound of zinc will cost $1 in constant U.S. currency. Projected output of primary zinc will be close to the 12 million metric ton mark by the year 2000, reaching possibly 13.5 million metric tons by the year 2004. The cumulatively mined quantity of zinc will be 189.2 and 240.9 million metric tons respectively. The consumption of slab zinc will rise accordingly but will always stay below the demand for total primary zinc.

The following conclusions can now be drawn:

The known economic zinc reserves of the world stand at 265 million metric tons instead of at the estimated 215 million due to the huge discoveries by China. This means that more zinc has been discovered than has been mined between the years 1973 and 1979 inclusive. However, the undiscovered economic reserves have now been reduced to 275 million tons. These reserves are sufficient to carry the world well into the next century. The total of economic reserves of 530 million metric

tons - discovered and undiscovered - would appear to be "exhausted" during the second decade of the next century, but very quickly rising zinc prices will add to the economic reserves and increased reliance on secondary zinc will modify the stringency of the expected supply scarcity.

Canada, as a whole, is still in a relatively fortunate position as it has mined zinc at a relative rate which is smaller than the proportion it holds in world reserves. However, the situation for the Province of Ontario may be less optimistic, unless new zinc orebodies are discovered. This is the central theme of the critical studies by Rachamalla and Bell: Ontario needs more zinc ore as present mines will be depleted by the year 2000!

Due to a lack of a synchronized mineral policy for the country as a whole, Canada will supply Japan's and Europe's (and Russia's) refineries with zinc feed. However, it could follow the examples set by Australia, Mexico and Peru and add to its refinery capacity. This would not inflict any harm upon our customers of ores and concentrates as long as their existing capacities are properly supplied. However, such action would be a deterrent to a further expansion of their refinery capacity. In turn, the feasibility of a Canadian refinery expansion could be supported, ex poste, by the Export and Import Permits Act[39] in placing zinc on the export control lists.

The U.S.A. will soon, most likely in the 1990s, be forced to increase the utilization of its own resources as the rising

world zinc demand will exert a mounting pressure on prices and the suppliers.

The U.S.S.R. will not fail to be one of the countries to exert such demand pressure. However, this country, at the same time, will also be forced through the circumstances to pay great attention to the discovery of new zinc reserves following the example of China which has demonstrated that great urgency in zinc demand will "ferret out" new deposits. Such sudden additional discoveries do not appear to occur in countries such as Canada where the dire need due to resource shortages has not yet shocked government and industry into a systematic exploration and comprehensive national resource assessment.

If any competitive pressure can be foreseen in the field of ores and concentrates, then, mainly from countries such as Australia, Mexico, Honduras and Peru which are exporters of ores and concentrates to the United States. However, in the field of refined zinc, the competition comes from those countries which import our ores and concentrates and sell them in the world market in refined form as well as from those endowed with ores and substantial refining capacities.

NOTES

1 Atomic weight 65.37; specific gravity 7 to 7.2; melting point: 419.5°C; boiling point: 907°C which allows for distillation; 132 ppm as the rate of mineral occurrence.

2 The zinc industry has a secondary zinc sector of smaller significance than lead. See, e.g. K.S. Rachamalla and D.H. Bell, "The Ontario zinc industry on a global scene and various government policies," Proceedings of the Eleventh Commonwealth Mining and Metallurgy Congress, Hongkong, 1978, Institution of Mining and Metallurgy, London, 1979, p. 36.

3 Wassily Leontieff et al., The Future of the World Economy, United Nations Study, Oxford University Press, New York, 1977.

4 See, e.g. Charles E. Kimbel Jr., "Zinc, Optimism evaporates as Demand sags and Prices show scant improvement," Engineering and Mining Journal, March 1980, p. 78-79.

5 The year 1979 shows a drop in every category but this comes about because ABMS, Non-ferrous Metal Data, 1979, New York, N.Y. introduced the residual item "undistributed consumption" for the first time into the statistics in 1979.

6 The following breakdown of industrial inputs of zinc in galvanizing, brass, die-casting and other uses may underscore the development aspects. Although annual data for 1960 and 1976 (1974 Europe) are used, the figures show that the rapid development finds expression in the expansion of die-casting as expressed of changes in the shares of zinc application.

	Europe		Japan		U.S.A.	
Year	1960	1974	1960	1974	1960	1974
Total consumption of Slab Zinc	1127	1728	198	697	796	1022
	%	%	%	%	%	%
Galvanizing	27.4	30.0	57.6	54.0	42.3	36
Brass	27.9	26.0	15.2	12.1	12.0	14.6
Die-casting	11.1	16.4	10.1	19.0	39.1	35.5
Other	33.6	27.6	17.1	14.7	6.6	13.9
	100.0	100.0	100.0	100.0	100.0	100.0

Source: Rachamalla and Bell, op. cit. p. 37 (Table). Differences existing between the breakdowns in this table and Table 3 of this study stem from the different composition of the basic information used to establish the two distributions.

7 See "Technical Information Paper No. 2, p. 19-20.

8 This reflects the fears expressed by Rachamalla and Bell in their paper before the Eleventh Congress of the Commonwealth Mining and Metallurgy Congress in Hongkong in 1978; see n.2. supra.

9 The change in position of the U.S.A. is even worse considering that in 1979 the U.S.A. produced as much zinc as it did e.g. in the years 1923 and 1924, or in 1936. In 1920, it produced 58% of the world's refined zinc. Its greatest output in this category occurred in 1969, after which it collapsed to 41.7% in 1977 of the 1969 level; cf. ABMS, op. cit., 1979, pp. 132-133.

10 U.S.A. zinc mine output: 1950: 565,500 metric tons; 1979: 263,670 metric tons. This means that the U.S.A. smelting and refining capacities went down hand-in-hand with the zinc mining sector. In comment to the refining and smelting capacities cited by other sources, it is admitted that some difference exists. For instance V. Anthony Commarota, Jr., Herbert R. Babitzke, and John M. Hague, "Zinc" in USBM op. cit., 1975, pp. 1223-1241, state the zinc smelting and refining capacities for the year 1973. Combined, they amounted to 6,096,000 metric tons, which is higher by 491,000 metric tons than the value obtained so far for this study. This publication by the USBM, however, included the

U.S.S.R. with 680,400 metric tons
China with 108,860 metric tons and
North Korea with 136,100 metric tons

or, by a total of 925,360 metric tons. If this difference is added to our value, then, the 1979 world zinc smelting - cum - refining capacity would have been, at least, 6,503,360 metric tons.

11 The writers are aware of the underlying homogeneity assumption for this type of argument as all quantities have been added regardless of the types of minerals or metals that were totalled.

12 A simple conclusion follows, viz. that the Belgium zinc industry lives on our zinc raw materials.

13 M.G. Fleming, "Man and Minerals - a Viable Contract," The Tenth Sir Julius Wernher Memorial Lecture, Proceedings of the Tenth International Mineral Processing Congress, Institution of Mining and Metallurgy, Alden Press (Oxford), 1974, xviii.

14 K.S. Rachamalla, and D.H. Bell, Towards a Zinc Policy for the Province of Ontario, Mineral Resources Branch, Ministry of Natural Resources, Mineral Policy Background Paper No. 3, Government of Ontario, 1976, p. 181; see for comparison Cammarota, et. al., loc. cit., p. 1228, who set the total at 5,080,320,000 metric tons with the following distribution:

North America	19.6%	Africa	5.4%
South America	5.4%	Asia	13.4%
Europe & USSR	33.9%	Oceania	8.0% and
		Seabed nodules	14.3% which have been

taken out of the discussion altogether!!

15 Cammarota et al., loc. cit.

16 Rachamalla and Bell, loc. cit.

17 Duncan R. Derry, World Atlas of Geology and Mineral Deposits, Mining Journal Books, London, 1980, p. 100 sets world reserves to be 240,000,000 metric tons. This would mean that reserves become available, presently, at about a rate of between 80 and 85 percent as they are exploited. The following breakdown stems from Duncan R. Derry's Table.(ibid.)

Canada	25.8%	Ireland	2.9%	Greenland	0.3%
U.S.S.R.	5.0%	Sweden	1.2%	Zaire	0.8%
Peru	2.9%	Spain	4.2%	Italy	1.5%
Australia	10.0%	China	0.8%(!)	Others	13.8%
U.S.A.	20.0%	W. Germany	0.8%		
Japan	1.9%	South Africa	6.4%		
Mexico	1.3%	Yugoslavia	0.4%		100.0%

See also his comment on p. 92 as to the reliability of all resource estimates! Cf. also H.W. Menard, Geology, Resources and Society, An Introduction to Earth Science, W.H. Freeman, San Francisco, 1974, pp. 526-527, who places the U.S.A. with 27% over Canada with but 20% as the world's two main zinc reserve holders!

18. Cf. Duncan, ibid., p. 92.

19 U.S. zinc tariffs are: (unit or ad valorem tariffs)

	MFN 1.1.1980	MFN 1.1. 1987	Non-MFN
Ores and concentrates	0.62 ¢/lb	0.3 ¢/lb	1.67 ¢/lb
Fume	0.62 ¢/lb	0.3 ¢/lb	1.67 ¢/lb
Unwrought (non-alloys)	1.9%	1.5%	1.75 ¢/lb
Alloys	19.0%	19.0%	45.0%
Waste and Scrap	4.8%	2.1%	11.0%

20 Another source sets the investment cost considerably higher and indicated that the delay was caused by considerations involving regulatory aspects of the EPA.

21 Cyprus Anvil supplied 15,000 of zinc concentrates, 8,725 tons came from Argentina because the imports of zinc from Iran dropped by 62,250 tons over 1978 to 10,000 tons only; Russian imports of Canadian zinc have been mentioned above. M.A.R. 1980, p. 591.

22 ibid, pp. 598-599.

23 ibid.

24 cf. Table 6 infra., p. 19.

25 M.A.R., 1980, p. 447.

26 Duncan R. Derry, loc. cit., p. 100.

27 M.A.R., 1980, ibid, for the left part of the listing and IMMR, 1980, op. cit., pp. 500-501, for the right part.

28 There are other lead-zinc mines: Shuikoushan (Hupeh Province) with a new orebody deep between other new deposits in 10(!) mining areas. Particularly, the lead-zinc deposit with the centre at Hochih is in the form of a belt which is "many tens of kilometres" long. The other large discovery is the Langping deposit in the Chingting mining district with 14 million tons of contained lead-zinc, with silver, selenium, tellurium and germanium as by-products (M.A.R., op. cit., p. 447). "Moderate quantitites of lead-zinc ore are produced in Xinjiang," ibid. The Liaoning Province has various small lead-zinc mines including Chingchengtzu, Hsinyen and Chaiho (ibid).

29 Cf. M.A.R., op. cit., p. 491, and IMMR, op. cit., pp. 92-94.

30 When taking the estimated total ore reserve into consideration, the life expectancy of that mine could be 140 years, ceteris paribus, of course! The quantity of concentrates to be produced, according to the second source, is 36,000 metric tons. Its mill thoughput is still 3,120,000 metric tons per annum.

31 Duncan R. Derry, ibid.

32 According to ABMS, 1979, op. cit., p. 77, Centromin's capacity is 75,600 s.t. whereas M.A.R. 1980, allocates to the same company a zinc capacity of 77,000 s.t., what might appear to be an insignificant difference.

33 Poland is a medium-sized but important producer. See Table 5, infra, p. 17.

34 Christopher Schmitz, World Non-ferrous Metal Production and Prices, 1700-1976, Frank Cass, London, 1979, pp. 299-301.

35 "Slower Growth Projected for mining," Engineering and Mining Journal, International Directory of Mining, 1978, S-19, which summarizes Dr. W. Malenbaum's predictions.

36 V.A. Cammarota, et. al., loc. cit., p. 1238.

37 Canada is spending $658.5 million to improve its zinc output. Arvik Mines will produce 187,000 metric tons of zinc concentrates by 1982, cost: $150 million. Brunswick Mining and Smelting will increase its output by over 10% at a cost of $210 million; Cyprus Anvil is investing $240 million in its deposit at Faro in the Yukon; and Les Mines Gallen, Ltd., P.Q. is spending $5.5 million to extract 250-375 thousand metric tons of ore with a 5.4% zinc grade, starting in 1981. Cominco is in the process of replacing its existing plant with a capacity of 300,000 metric tons per year.

38 That a favourable exchange rate helps exports while the tariff policies of the industrialized countries tilt the balance towards the exportation of untreated zinc need not be mentioned explicitly.

39 Government of Canada, "Export and Import Permits Act," R.S.C. 1970, as amended by S.O.C. 23 Elis.II, "An Act to amend the Export and Import Permits Act," c.9,s.3 (1,a,1)!

APPENDIX

ZINC: EXPORTS AND IMPORT

TABLES A1 - A9

Table A1

Zinc in Ores and Concentrates (commodity 257-10)

Year	Quantity (metric tons) Exports	Value ($'000) Exports
1979	598,531	233,793
1978	686,232	183,409
1977	555,635	201,714

Distribution of Shipments

1977	Bel-Lux	47%	1978	Bel-Lux	28%	1979	Japan	29%
	Japan	20%		Japan	22%		Bel-Lux	28%
	U.S.A.	10%		U.S.A.	20%		U.S.A.	19%
	West Germany	8%		West Germany	11%		West Germany	10%

U.S.S.R. in 1977 - 03%; in 1978 - 01%; in 1979 - 02%

Table A2

Zinc, Zinc Alloy Scrap, Dross Ashes (commodity 257-39)

Year	Quantity (metric tons) Exports	Value ($'000) Exports
1979	15,443	5,026
1978	19,173	5,178
1977	19,136	3,800

Distribution of Shipments

1977	U.S.A.	78%	1978	U.S.A.	70%	1979	U.S.A.	67%
	U.K.	14%		U.K.	14%		U.K.	19%

Table A3

Zinc in Ores, Concentrates and Scrap (commodity 257-99)

Year	Quantity (metric tons) Exports	Value ($'000) Exports
1979	9,868	5,646
1978	6,145	2,048
1977	6,048	2,822

Distribution of Shipments

1977	U.S.A.	54%	1978	U.S.A.	46%	1979	Bolivia	41%
	Peru	32%		Bolivia	25%		U.S.A.	36%
				Peru	17%		Peru	20%

Table A4

Zinc Dust and Granules (commodity 457-04)

Year	Quantity (metric tons)			Value $'000		
	Exports	Imports	Balance	Exports	Imports	Balance
1979	3,641	304	3,337	3,775	401	3,374
1978	4,206	272	3,934	4,076	327	3,749
1977	3,521	156	3,365	3,730	181	3,549

Distribution of Shipments

Exports	1977 - U.S.A.	97%	Imports	1977 - U.S.A. 98%
	1978 - U.S.A.	95%		1978 - U.S.A. 96%
	1979 - U.S.A.	96%		1979 - U.S.A. 99.7%

Table A5

Zinc Blocks, Pigs and Slabs (commodity 457-08)

Year	Quantity (metric tons)			Value $'000		
	Exports	Imports	Balance	Exports	Imports	Balance
1979	429,360			355,521		
1978	439,268			311,446		
1977	295,364			222,566		

Distribution of Shipments

Exports	1977 - U.S.A.	70%	1978 - U.S.A.	59%	
	U.K.	15%	U.K.	12%	
	1979 - U.S.A.	61%			
	U.K.	11%			

Table A6

Zinc Slabs, Blocks, Pigs and Anodes (commodity 457-10)

Year	Quantity (metric tons) Imports	Value $'000 Imports
1979	2,572	2,501
1978	2,405	1,840
1977	3,328	2,386

Distribution of Shipments

Imports	1977 -	U.S.A.	26%	1978 - Peru	46%
		China	22%	U.S.A.	34%
		Netherlands	18%		
		1979 - Peru	91%		

Table A7

Zinc Bars, Rods, Plates, Strip and Sheet (commodity 457-30)

Year	Quantity (metric tons) Imports	Value $'000 Imports
1979	468	843
1978	386	568
1977	433	759

Distribution of Shipments

Imports	1977 -	U.K.	46%	1978 - U.S.A.	56%
		U.S.A.	41%	Netherlands	26%
		1979 - U.S.A.	43%		
		Peru	26%		

Table A8

Zinc Slugs, Discs and Shells (commodity 457-32)

Year	Quantity (metric tons) Imports	Value $'000 Imports
1979	74	68
1978	15	13
1977	9	5

Distribution of Shipments

Imports 1977 - U.S.A. 100% of total quantity
1978 - U.S.A. 100%
1979 - U.S.A. 51%
Bel-Lux 49%

Table A9

Zinc Fabricated Materials NES (commodity 457-49)

Year	Quantity (metric tons)			Value $'000		
	Exports	Imports	Balance	Exports	Imports	Balance
1979	1,935	877	1,058	2,780	2,253	527
1978	1,308	917	391	1,889	2,145	(-) 256
1977	2,024	1,139	885	1,982	2,747	(-) 765

Distribution of Shipments

Exports 1977 - U.S.A. 88% 1978 - U.S.A. 91% 1979 - U.S.A. 76%

Imports 1977 - U.S.A. 84% 1978 - U.S.A. 90% 1979 - U.S.A. 86%
U.K. 13%